one dissertation has been presented by two men working together. The big problems of biology are already too large for individual attack. We must have biologists, chemists, geneticists, statisticians, bacteriologists, pathologists—all working together to adequately solve them—and how much more rapidly science would advance if we could secure such cooperation! A specialist for every phase rather than a "Jack of all sciences" attacking the problem alone. And what part is Sigma Xi to play in it all? Sigma Xi if it is to play any part must yield to the processes of evolution or be passed in the race.

Sigma Xi was founded because scientists felt the need for a bond to draw them together and to propagandize in favor of science in the universities. In that day Latin, Greek, the languages and literature, history and philosophy, were the recognized collegiate courses. Science had not come into its own. What part Sigma Xi played in the establishment of science courses will probably never be accurately determined, but the day is already past when science needs any assistance in establishing its proper place in a university curriculum. Science has arrived! And with the evolution of science I am afraid Sigma Xi is being left behind. We no longer get together in scientific meetings to discuss the individual researches of science workers. Science has become too specialized. Many a university now has its chemical society, its pathological society, its society of clinical medicine, its physical society, its mathematical society, its botanical society, its physiological society, etc., etc. To be sure we call them seminars in many instances, but the result is the same. There are likewise new "Honorary" societies being formed, such as Phi Lambda Upsilon for chemistry, which have a special attraction for a special group. Where then is Sigma Xi's place in this new order of things?

If Sigma Xi is to live to fulfill the hopes of its founders it must meet the challenge of the new order with a definite mission. I believe that there is a place for Sigma Xi in the new order. It was created to foster science—why should its new mission not be to coordinate science, to foster cooperation, to be the guiding hand in establishing an *esprit de corps* among science workers, to attract to the universities noted lecturers in special branches of science, especially those branches which are the weakest in the university in question, to assist in the securing of the formation of special scientific bodies within the university, especially the honorary scientific societies of the special groups? For after all, it is the *specialist*, not the scatterer, who brings fame to a university. In short, Sigma Xi should be the keystone of the scientific structure and should devote all of its energies to those means which will advance the special sciences and which will draw scientific workers into a union so that they may attack the great problems of the future.

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THE RELATION OF CHEMICAL TRAINING TO INDUSTRY [1]

THE relation of chemical science to education and industry is no new problem. During the last few years a quantity of opinion and advice has been offered to us and, as one result at least, the fact stands out that there is need of adjustment between educational institutions training scientific men and the industries which these men are to serve.

Looking back historically, it seems evident that the present misunderstanding between the two great parties concerned arose because of the different points of view as to how (*a*) the results of scientific discovery, and (*b*) the young graduates in science prepared at our colleges and universities could best be utilized in industry. The teachers of science are often unfamiliar with the needs of industry in regard to the nature of the problems to be solved and in regard to the kinds of scientists needed in our highly organized commercial enterprises. On the other hand, manufacturers are often at a loss as to how

[1] President's address before the Kentucky Academy of Science, Lexington, May 14, 1921.

scientific men and discovery can best be utilized in industrial development and are apt to discount university research because it deals with pure science, the employer being unable to see the practical advantage to him of such work.

That this question is fundamental there is no doubt. One has but to glance over the advances made in any of our leading industries during the last twenty years to note and appreciate the importance of the scientifically trained man in, and his services to, our commercial organizations. In fact, when we mention coal and coal gas, dyes, explosives, cellulose, rubber, cement, pottery, photography, food, brewing, etc., our minds immediately refer to the great progress achieved recently in the industries because of the scientific worker. During the past few years scientific development of warfare has brought the pure and applied scientist together to an extent which was before deemed impossible, and this is a happy augury as to the future collaboration between these classes. The old isolation is now impossible and yet the question remains, as before, as to the best methods of training our graduates in science to fit them for industrial work. In other words, how can we best get team-work between the scientific producer and the scientific user? It has been said[2] that "the two fundamental essentials to successful team-work are an intelligent mutual understanding and a real spirit of give and take cooperation." The first of these will come with time, experience and education; the second may be discussed under the two following heads:

First, Industry and the College Graduate.—From opinions expressed by leaders in the industrial field, and from the questionnaires sent out by them concerning applicants for employment, it seems that the character, initiative and *resourcefulness* of the young graduate are valued by industry equally with technical knowledge. In many cases scientific training is considered the less important of the above characteristics. If this be true, it necessarily follows that an increased amount of time must be spent by the student in developing wide academic relationships. In other words a wide, basic training to develop observation, reasoning, imagination and character in general is essential. The fact that, in our educational processes, we are getting farther and farther away from this idea of a wide, basic training, does not need discussion. This is literally an age of intense specialization. The question asked by college graduates is not "what work will give me the best and broadest education" but "what courses will enable me to get the best paid job as soon as I graduate?" It seems to the writer that specialization in the secondary schools and the first two years of the college course should be reduced to a minimum and be devoted to a broad, basic education. Even when specialization is begun a knowledge of fundamentals and principles, together with an ability to apply them to any concrete problem, is of much greater value to the student than the possession of an endless chain of facts. Very happily this idea is becoming more and more popular with writers of chemical text-books and our courses, even in elementary chemistry, are less and less descriptive as time goes on. The same conception may profitably be applied to a selection of courses as well as to the material in any one course. Gas analysis is simply an application of quantitative analysis, and the student who has mastered the principles of the larger subject should be able to apply them to the former without taking a formal course in that subject. A knowledge of English grammar is more important to him than a course in water analysis if he has to choose between the two. Unfortunately, this point of view has been grasped neither by the student nor by many employers, though the results have shown the argument to be a sound one. In this connection it is interesting to note that one of our prominent eastern universities intentionally omits such subjects as water analysis from its courses required of men specializing in chemistry, stating that the time thus saved may be

[2] H. P. Talbot, *J. I. and Eng. Chem.*, Oct., 1920.

better devoted to other subjects such, for example, as instruction in the use of a chemical library. There is no doubt but that many of our graduates do not fully appreciate the fact that the final source of chemical knowledge is the chemical literature and they are not over familiar with methods for its use which assume a reading knowledge of scientific French and German together with required courses in chemical literature such as are now being given at the University of Pittsburgh. Surely such training can rightly be, and is, demanded of educational institutions by industry. Industry asks further that the college graduate be so trained that he can quickly comprehend the essential points in any research problem and separate the significant from the unessential. He should have a good grasp of experimental technique and detail and, paradoxical as it may seem in connection with commercial work, be able to work with small quantities as well as with large amounts of material. Since the success of most industries is dependent upon physical factors such as pressure and temperature, the research worker should be trained to watch for and detect the variable factors which are present and entering into his experiments.

It is not an easy matter to place the blame for the fact that the graduate does not meet the requirements stated above. The secondary school must be held accountable for some and the college for others. The secondary school does not sufficiently train the senses, so necessary to the scientist, but tends to develop the memory. Furthermore, the boy's curiosity is dulled even though this characteristic and the all important imagination go hand in hand. In college, often, the memory training continues instead of developing reasoning ability. The student relies implicitly and blindly on his text-book; without it he is lost. He is unable to stand on his own feet and replies, when given a reasoning question, that "it is not in the book." This is not a plea for the lecture system but is directed against the all too popular custom of memorizing printed pages. The technical school, also, is open to criticism because technical courses are often taught by those not in touch with industry.

The remedies for these conditions suggest themselves and no further comment on most of them is necessary except to state that even routine laboratory work may be made of value for research training by considering each preparation by itself as a research problem and treating it accordingly. Theories and principles may well be emphasized to the exclusion of some descriptive matter and their industrial application in many fields be pointed out.

To meet the objection that graduates have had no practical experience in industry the so-called cooperative courses of study have been organized in several institutions, notably the University of Cincinnati and the Massachusetts Institute of Technology. Under this plan the student divides his time between the university and some industrial plant, securing the theory at the former and the practical experience and handling of industrial apparatus at the latter. These courses are of five years' duration ordinarily and, being open only to students of ability, are fulfilling their mission successfully. This is one example of real cooperation between industry and educational institutions which is of direct advantage to the former. Another phase of this matter is that commercial organizations could, to their own benefit at a later date, employ high-grade college students during the summer vacation. These men, often of high ability, are many times prevented from graduating because of financial difficulties. Employment during the summer would furnish the necessary means for completion of the university work and the graduate would, upon taking his place in industry, more than repay it for the assistance rendered him. Thus the Standard Oil Company not only gives selected students employment during the summer months but, after the college course is completed, places them on salary in special schools where training for the future work is secured. Other large organizations have adopted the same plan with benefit resulting to both parties concerned.

Second, Industry and College Instructors.—As in the past, the research interest of the college instructor will always be in pure or abstract science and there can be but little doubt that this position is the correct one. Looking back over the development of industry it seems clear that research in pure science is the forerunner and always precedes industrial application. Though an investigation in abstract science may, at the time of its completion, be of no practical use to humanity, there is no reason to suppose that the time will not come when this research may be so utilized; in fact we have numberless examples of just such cases. Research in our educational institutions should be encouraged as much as possible, first, by the endowment of research laboratories and, second, by relieving as much as possible the research staff of an institution from teaching engagements in order that its members may have the maximum of time for investigation. When industrial problems arise which are in need of immediate solution, such institutions as the Mellon Institute of Industrial Research may be utilized in which a research problem of direct interest to an industry may be prosecuted, the firm deriving all of the benefits of the investigation and defraying its expenses. Commercial organizations may show their appreciation of research by endowing scholarships and fellowships in educational institutions and thus help to place this phase of educational work upon a firm, enduring footing. Industry ultimately benefits by research and therefore can logically be called upon to support it. An encouraging start has been made in this direction, many of our universities being the recipients of scholarships endowed by commercial organizations, thus assuring the research teacher of assistance and means to carry on his work. The question as to how the instructor can best keep in touch with industrial operations is not one easy of answer. He might well devote a part of his time to the solution of technical problems, thus gaining practical experience that would be of great assistance to him in his teaching. There are, however, at least two objections to this: (1) The results of such an investigation could necessarily not be published, because, as long as there is commercial competition, technical investigation will be conducted secretly and (2) there is danger of converting an educational laboratory into an adjunct to a commercial enterprise. This last is obviously an impossible situation and a misuse of public and private endowment given for educational use. Whether or not it will be possible to strike a happy medium only time can tell.

In conclusion, the report of a committee of the American Chemical Society[3] dealing with this subject is of interest. Briefly summarized it runs as follows:

"(1) The most important contribution which the universities can make to the industries of this country is to supply them with sufficient numbers of men thoroughly and broadly trained in the principles of chemistry.

"(2) Because of the tendency to draw men, effective in research work, away from universities into industrial work by the payment of higher salaries, it seems evident that, unless a considerable increase in salaries of teachers can be secured, the next generation of chemists is likely to be trained by a set of mediocre men.

"(3 and 4) Fellowships leaving the teacher and student free to select the topic of research as well as those designed to promote the solution of some industrial problem are both desirable. The results of the latter should be published and not be the property of any one firm.

"(5) Fellowships designed for the benefit of a single firm should be subject to very careful restrictions. The firm should pay for the services of the instructor as well as the fellow, and for the use of the laboratory facilities. The results should be published within two years after the expiration of the fellowship. Fellowships preparing men for specific industries are desirable provided the industry is a large one and the character of the training is left to the discretion of the

[3] *J. Ind. and Eng. Chem.*, May, 1919.

department. Emphasis should be placed on the broadest theoretical training. The holder of the fellowship should be free (not under contract) at the end of his period of study.

"(6) In passing on candidates for the degree of Ph.D., emphasis should be put on a thorough training in the fundamental principles of chemistry and upon high attainment in research, rather than upon period of study."

This is the present opinion on the question. Whether time will modify it we can not tell, but the suggestions outlined above, if rigorously carried out, will tend to bring about a closer cooperation between chemical science and industry than now exists.

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ANTHROPOLOGY IN THE MEDICAL CURRICULUM

The problem of human types is one that has baffled the ages, but it is at present in a fair way toward solution. The temperaments as depicted by Albrecht Dürer in the forms of four apostles, and as taught at the School of Salernum, based upon the four elements and upon the four humors of Hippocrates, and known as the melancholic, choleric, phlegmatic and sanguine, may not be generally accepted, and the phthisical and plethoric may have a greater significance, but until the physical and psychical types are studied upon a more exact and scientific basis the types of man may remain as myths to the laity as well as to the medical profession.

Manouvrier was the first to place the types of man as found among the Europeans upon an exact basis by actual measurement, and his classification into brachyskele, mesatiskele and macroskele, or broad, medium and long skeleton, is working its way into medicine. Godin has applied the methods of Manouvrier to children in the evaluation of growth with illuminating results. Others have utilized the same methods in the differentiation of races and in the segregation of types within the race.

The best means of differentiating human types is by anthropometry and inspection. The type may be decided by a careful inspection of the external form of the ear, nose, face, head and body form after one has become familiar with the types by prolonged experience. It is possible by the ear form alone to determine differences of 10 feet in the length of the small intestine, of 500 grams in the weight of the liver, of differences in the size of the brain, cerebellum, heart, kidneys and spleen, of the position and shape of the viscera; thus anthropology becomes the handmaid of anatomy in the medical curriculum, an essential adjunct in teaching medicine. Different human types represent different forms of intellect and different immunities and susceptibilities to disease, hence psychology and pathology become associated with anatomy and anthropology.

Adult human types probably represent the end products of chemical reactions that have been continuously at work throughout the life of the individual, or at least a large part of the life. It is only fair to assume that the net result of this activity will be easier to perceive than the chemical reaction at any particular moment. It may be fruitless to attempt to determine or differentiate chemical types, although the serum reactions may be so delicate that they will suffice to make clear minute differences.

Such a piece of work as that published in *L'Anthropologie* by Dr. L. and Madame H. Hirschfeld may interest physiologists, pathologists and internists. Serum tests were made during the Great War on about 500 soldiers in each of many national groups of Europe, of Asia and of Africa, and differences were found that amounted to more than 50 per cent. The tests were so acute and positive that individual heredity could be determined, the parentage of any child verified.

Dr. Goldthwait, in the Shattuck Lecture for 1915, presents the types of man as a basis for diagnosis and treatment, as do Percy Brown and Bryant. There is also an editorial in the number of the *Boston Medical and Surgical Journal* which has the Shattuck Lecture, wherein, with prophetic vision, the editor